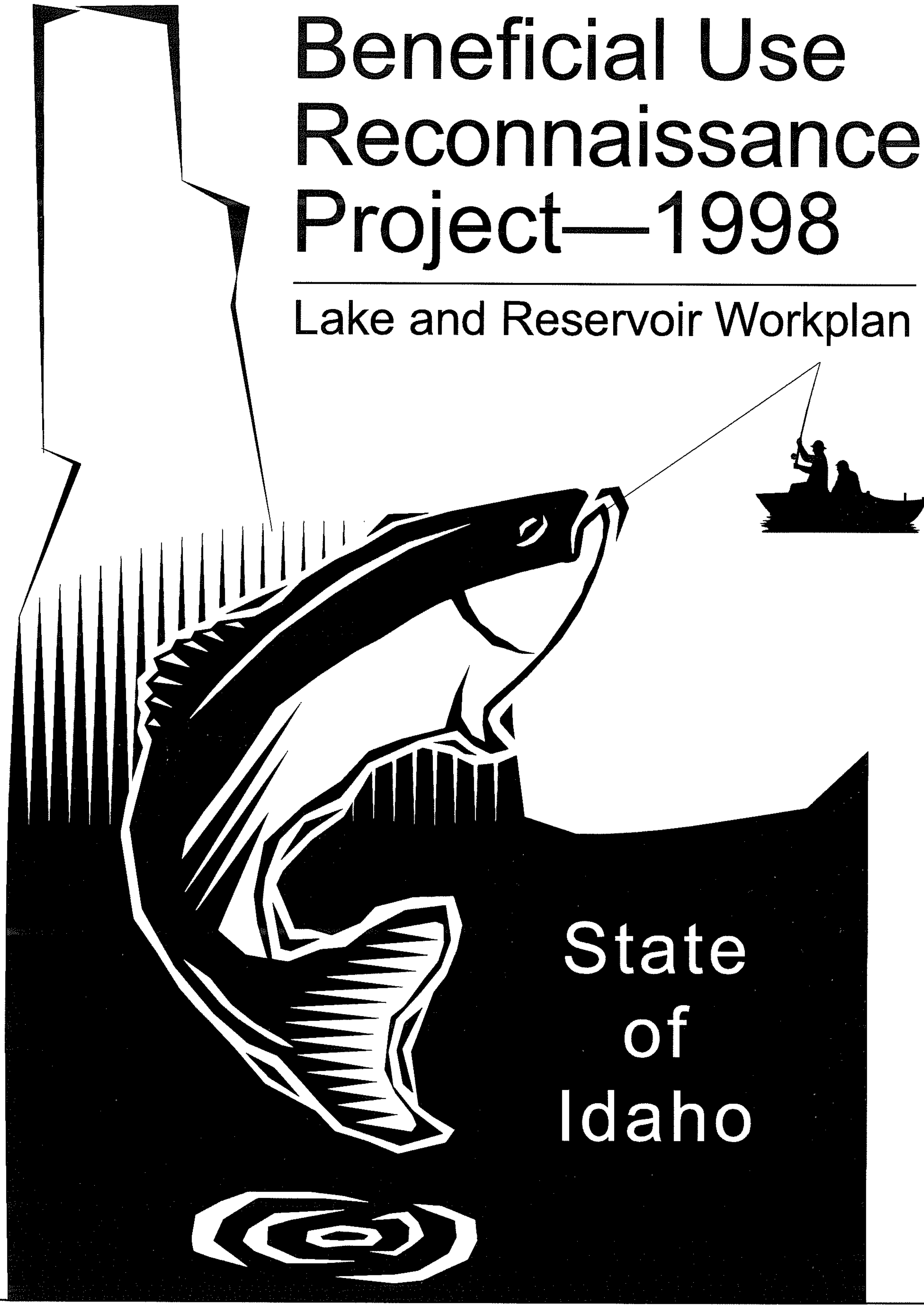
Beneficial Use Reconnaissance Project—1998

Lake and Reservoir Workplan



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Lake and Reservoir Workplan

June 1998

Prepared for
Idaho Division of Environmental Quality
by
Beneficial Use Reconnaissance Project Lake and Reservoir Committee

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Introduction

Creation of the Beneficial Use Reconnaissance Project

In 1993, the Idaho Division of Environmental Quality (DEQ) embarked on a pilot project aimed at integrating biological and chemical monitoring with physical habitat assessment as a way of characterizing stream integrity and the quality of the water (McIntyre 1993a). This project was also developed in order to meet the Clean Water Act requirements of monitoring and assessing biology as well as developing biocriteria. This pilot, named the Beneficial Use Reconnaissance Project (BURP), relied heavily on protocols for monitoring physical habitat and macroinvertebrates developed by the DEQ in the early 1990s (Burton and Harvey 1990; Burton et al. 1991; Cowley 1992; Clark and Maret 1993). It closely followed the U.S. Environmental Protection Agency's (EPA) *Rapid Bioassessment Protocols for Use In Streams and Rivers* (Plafkin et al. 1989). These protocols were an attempt to use the best science and understanding available to characterize water quality based on biological communities and their attributes. Because of the success of the 1993 pilot, the DEQ expanded the project statewide in 1994 (McIntyre 1994; Steed and Clark 1995). It has remained in effect statewide since then.

The 1997 BURP Workplan incorporated protocols for two new water body types: one for lakes and reservoirs and another for large rivers (Beneficial Use Reconnaissance Project Technical Advisory Committee 1997). The lake and reservoir reconnaissance-level protocols were primarily fashioned after Milligan et al. (1983), Mossier (1993), and U.S. Environmental Protection Agency (1997). These protocols were reviewed in 1998. The Lake and Reservoir Committee have made revisions.

Purpose

The purpose of the 1998 BURP workplans are to provide statewide consistency in monitoring and data collection as described in the *Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho* (Clark 1990). This document describes lake and reservoir data collection under the BURP process. It lays out the assumptions, methods, and equipment required.

This document does not describe the analysis and interpretation of the data. Interpretation of BURP data and any other relevant water-quality information is described in the DEQ's Water Body Assessment Guidance (Idaho Department of Health and Welfare 1996a). The Water Body Assessment Guidance document outlines the process the DEQ uses in determining: 1) designated and existing beneficial uses and 2) beneficial use support status (*e.g.* full support, not full support).

Goals and Objectives

The goal of the lake and reservoir beneficial use reconnaissance-level monitoring project is to develop protocols applicable to lentic waters focusing on cost-effective measures that relate to beneficial uses and respond to levels of human influence. This goal should be achieved with the following objectives:

1. document the existing beneficial uses to the extent possible at a reconnaissance-level intensity; and

2. determine if reconnaissance-level protocols are feasible, applicable, and usable.

Feasibility: Equipment needs, personnel skills, safety precautions, training requirements, and time required to complete monitoring are reasonable.

Applicability: Methods can be implemented statewide.

Usability: Data collected provides meaningful information related to meeting the goal.

Rationale for Selected Measures

Measures were selected by the Lake and Reservoir Committee based on BURP objectives, relevant studies, and personal experience. Many measures relate directly to beneficial uses, such as aquatic life and recreation. Others may be a surrogate when beneficial uses can not be measured directly. Minshall (1993) suggested using multiple measures because "it is unlikely that any one measure will have sufficient sensitivity to be useful in all circumstances."

Physical/Chemical

Bathymetry or Depth

Water-basin morphology--or the area, depth, and shape of the water basin--influences water-body hydrodynamics and responses to pollution (Mortimer 1974). Depth is an important physical variable in classifying lakes and reservoirs. Deep lakes are generally oligotrophic while shallow lakes tend to be eutrophic (Milligan et al. 1983; Bellatty 1989a, 1991; Mossier 1993; Lockhart 1995). While depth likely plays some role in holding down summer temperatures, its greatest effect seems to be in dilution capacity. Woods (1991) found nutrient concentrations increased with depth in Pend Oreille Lake, Idaho's deepest lake, which thereby acts as a sink. Mean depth has also been related to hypolimnetic oxygen deficits (Cornett and Rigler 1979, 1980). It has been used with macrobenthic biomass to predict fish yield (Hanson and Leggett 1982). Mean depth and dissolved solids (morphoedaphic index) accurately predicted phytoplankton standing crop (Oglesby 1977a) and fish yield (Ryder et al. 1974; Oglesby 1977b).

Conductivity

Conductivity, or specific conductance, refers to the ability of water to conduct an electrical current. It is an indication of the concentration of dissolved solids. Kunkle et al. (1987) found conductivity to be an useful indicator of mining and agricultural effects. Royer and Minshall (1996) found sites designated as degraded generally had higher conductivities. Maret et al. (1997) reported conductivity is one environmental factor determining the distribution of fishes.

Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life and is an important indicator of water-body health. It is a priority measure in lake monitoring (U.S. Environmental Protection Agency 1988). Much information can be obtained from this single measure. Water column dissolved oxygen concentrations determine which aquatic organisms will be able to exist. It is related to the photosynthetic activities of algae and macrophytes as well as to the decomposition of organic material. Dissolved oxygen gradients can supply insight into the mixing patterns of a water body and the extent of dissolved-oxygen deficits. Anoxic conditions can influence other chemical properties of water through the oxygen-reduction potential (Wetzel 1983).

Hydrogen Ion Concentration (pH)

Hydrogen ion concentration, or pH, as with temperature, is an important regulator of many biological and chemical processes. The composition of aquatic communities is strongly influenced by pH (Marcus et al. 1986). The uptake and release rates of ions across gills, the primary method of ion regulation in aquatic animals, is at least partly pH-dependent (Smith 1982). Similarly, the toxicity of some chemicals is pH-dependent (Wetzel 1983).

Littoral Bottom Substrate

Sediment and its accumulation is detrimental to beneficial uses, particularly aquatic life, since it limits the quality and quantity of the inter-gravel spaces that are critical for egg incubation (Scrivener and Brownlee 1989; Young et al. 1991; and Maret et al. 1993). Fine sediment and availability of living space have direct affect on both fish and insects (Minshall 1984; Marcus et al. 1990). Several studies and state projects have found relative substrate size to be important indicators of water quality effects due to activities in the watershed (Skille 1991; McIntyre 1993b; and Overton et al. 1993).

Nutrients

Phosphorus and nitrogen are essential elements for plant growth. Excessive nutrients, however, can lead to eutrophication. This condition is termed "cultural" eutrophication when it is human-caused and has been found to be of concern to national waters (U.S. Environmental Protection Agency 1977). Heiskary and Walker (1988) reported excess nutrient concentrations resulted in aesthetic and "swimmability" problems. Nutrients have been used as an important chemical variable in determining trophic state (Vollenwieder 1976; Dillion and Rigler 1974; Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). Phosphorus has been found to be correlated to the concentration of chlorophyll *a* (Dillion and Rigler 1974; Carlson 1977; Oglesby 1997a; Lee and Jones 1984) and fish yield (Lee and Jones 1984; Hanson and Leggett 1982; Hoyer and Canfield 1991). Particulate inorganic phosphorus is adsorbed to soil particles and enters waters by sediment transport from the watershed, and is therefore an indication of land disturbance.

Photo Documentation and Diagrammatic Mapping

Photographic records provide visual details of land use, shoreline vegetation conditions, water-level fluctuations, characteristics of littoral biological communities, et cetera. Diagrammatic mapping is a representative map of the water body. Mapping provides spatial information and an approximate scale of important characteristics such as land use, habitat features, and shoreline conditions (Meador et al. 1993). Such visual details compliment field notes and physical measures. This type of documentation may also provide baseline information concerning qualitative changes of land use, shoreline vegetation conditions, and shoreline modifications.

Shoreline Physical Habitat Characterization

Water-level fluctuations can affect aquatic life. Jeppson (1954) and Bowler et al. (1979) found manipulation of water levels for hydroelectric power generation and flood control adversely affected kokanee *Oncorhynchus nerka* spawning and incubation in Pend Oreille Lake and its tributaries. Falter et al. (1992) speculated water-level fluctuation desiccated shallow areas and thus prohibited Eurasian water milfoil *Myriophyllum spicatum* var. *Spicatum*, an invasive aquatic macrophyte, in Pend Oreille Lake.

The presence and condition of the shoreline vegetation is important to the overall ecological health of a water body. Healthy vegetative stands provide biofiltration strips for sediment, nutrients and toxic substances; stabilize shorelines; sustain water levels; and provide essential habitat for aquatic-associated wildlife (Belt et al. 1992; Castelle et al. 1992).

Shoreline condition and material types correlate to erosion potential. Removal of vegetation reduces structural stability and negatively affects fish productivity (Platts and Nelson 1989; Platts 1990). Banks stabilized by deeply-rooted vegetation, rocks, logs, or other resistant materials are less susceptible to erosion (Bauer and Burton 1993).

Temperature

Water temperature is an easily-measured physical measure that has considerable chemical and biological significance. Essentially all aquatic plant and animal processes are temperature-dependent. Increased water temperatures are known to increase biological activity, and temperature can reach lethal limits for fishes (Smith 1982). The potential, or maximum, dissolved oxygen concentration is inversely proportional to water temperature (Wetzel 1983).

Temperature profiles are one of the highest-priority measures in lake monitoring (U.S. Environmental Protection Agency 1988). Identification of thermal stratification, a common characteristic of lakes, is often the emphasis of such profiles. In their simplest form, lake strata include a layer of warm, relatively light surface water (epilimnion) and a cold, dense layer on the bottom (hypolimnion) separated by a transition layer (metalimnion or thermocline) with a strong temperature gradient (equal to or greater than one degree Celsius per meter depth). The gradient prevents the epilimnion from circulating any deeper, thus isolating the hypolimnion waters from the water body's surface. The significance of stratification is that no exchange of dissolved constituents, such as gases or nutrients, is possible between the epilimnion and the hypolimnion. Organic material produced in the epilimnion settles into the hypolimnion and bottom sediments where it is decomposed during summer stratification. Dissolved oxygen is used in the decomposition and cannot be replenished, thus decreasing the amount of dissolved oxygen available to life in the water column.

Water Clarity

Secchi-disk measurement is a simple, effective, and widely-used method of determining water clarity. Clarity of water has been an important physical variable in determining trophic state (Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). The U.S. Environmental Protection Agency (1988) ranked it as one of the highest-priority measures in lake monitoring. Secchi-disk transparency is influenced by the absorption characteristics of water. It has been correlated to chlorophyll *a* (Carlson 1977; Mills and Schiavore, Jr. 1982) and is influenced by other factors such as turbidity and dissolved organic color. Chambers and Kalff (1985) reported the depth of light transmittance relates to maximum macrophyte depth. Mossier (1993) concurred that the two were highly, positively correlated. Because of its relation to water clarity--a measure readily observed by users of water bodies--Secchi-disk measurement is a good surrogate for the public's perception of water clarity.

Biological

Aquatic Macrophytes

Aquatic macrophytes affect water quality through species presence and abundance. Mossier (1993) found the diversity of prevalent species generally demonstrated a twofold increase from eutrophic to mesotrophic to oligotrophic lakes. Coots and Carey (1991) measured mean oven dry weights of about two kilograms per squared meter in areas of nuisance aquatic macrophyte growth. Some natural systems have unacceptable conditions for macrophyte establishment due to depth (decreased light transmittance), turbidity, wave action, unstable substrate, and water level fluctuation (Falter et al. 1992). Depending on the ecology of the system, macrophytes may typically provide food (in the form of detritus) and shelter. In ecologically unstable conditions, however, macrophytes may produce dense mats that are aesthetically objectionable (Coots and Carey 1991; Allen 1995) and reduce fish yield (Coots and Carey 1991). Consequently, macrophytes are an important component of the biological community. Some macrophyte indices have been developed and used in other bioassessments (Lockhart 1995; Small et al. 1996).

Fecal Coliform

Although fecal coliform is not a pathogen, its quantification has been used as a surrogate for measuring pathogens in the water column. The State of Idaho has set water-quality standards to protect recreational beneficial uses through numerical fecal-coliform criteria, (IDAPA 16.01.02.250.01 Water Quality Standards and Wastewater Treatment Requirements).

Fish

Fish contribute significantly to the ecology of the aquatic community. This biological assemblage is highly visible to the public and is an important economic resource in Idaho. Additionally, fish have relatively long life spans that can reflect long term and current water-quality conditions. Due to their mobility, fish also have extensive ranges and may be useful for evaluating regional and large habitat differences (Simon and Lyons 1995).

Macroinvertebrates

Chemical monitoring is not always representative of the long term water-quality condition because most waters are monitored infrequently. Biological monitoring provides an integrated representation of water-quality conditions because the biological community is exposed to the water's characteristics over a longer period of time. Macroinvertebrates are one assemblage that reflects a water's overall ecological integrity. This biological assemblage is an useful assessment tool because it is ubiquitous, includes numerous species, and responds to physical and chemical impacts in the water column (Rosenberg and Resh 1993). Additionally, macroinvertebrates with certain environmental tolerances may provide some insight of pollutants (Johnson et al. 1993).

Periphyton

Periphyton is an useful indicator because of its wide distribution, numerous species, and rapid response to disturbance (U.S. Environmental Protection Agency 1996). Periphyton integrates physical and chemical effects. Diatoms, a type of periphyton, have frequently been identified as useful biological indicators particularly in Montana, Kentucky, Oklahoma, and European countries (Round 1991; Rosen 1995).

Phytoplankton/Chlorophyll *a*

Phytoplankton is largely responsible for primary production in aquatic environments (Wetzel 1983). Virtually all dynamic features of water such as clarity (Carlson 1977; Mills and Schiavore, Jr. 1982), trophic state (Dillion and Rigler 1974; Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989), zooplankton (Mills and Schiavore, Jr. 1982; Canfield and Watkins 1984), and fish production (Ryder et al. 1974; Oglesby 1997b; Jones and Hoyer 1982) depend to a large degree on the phytoplankton. Power et al. (1988) found beneficial uses can be affected by excess phytoplankton in lakes and slow-moving water bodies.

The quantity of phytoplankton indicates the degree of eutrophication. Chlorophyll *a* concentration is an often used surrogate measure for phytoplankton abundance (Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). Chlorophyll *a* concentration can help determine the degree of degradation and can be used to determine if high levels of critical nutrients are present (Dillion and Rigler 1974).

The quality, or speciation, of phytoplankton is equally as important. Many forms have different physiological requirements and vary in response to physical and chemical measures such as light, temperature, and nutrients. Mossier (1993) found blue-green algae were a significant and dominant part of the phytoplankton community for many eutrophic and mesotrophic lakes, while oligotrophic lakes showed no blue-green algae. Falter et al. (1992) noted the ascendancy of green and blue-green algae in Pend Oreille Lake was an indicator of increased pelagic productivity.

Zooplankton

A cost-effective surrogate to assessing the fish community is to evaluate the zooplankton community. This approach is especially applicable for planktivorous fishes, *e.g.* kokanee and yellow perch *Perca flavescens* (Wallace 1982). Mills and Schiavore, Jr. (1982) developed an index to predict the predator and prey balance in fish communities. Simply put, mean body length of crustacean zooplankton are equal to or greater than 1.0 mm in waters where predation is successfully controlling zooplankton density. The dominance of smaller zooplankton suggests an insufficient number of predators.

Pre-Monitoring Steps

Criteria for Use

Lakes are easily identifiable, however, reservoirs may be confused with large rivers. Certain criteria distinguish lakes from small ponds and wetlands and reservoirs from riverine pools. Open water with a surface area greater than one hectare will characterize lakes. Thornton (1990) reported hydraulic residence time in reservoirs is greater than 14 d. (This criterion should be estimated if hydraulic residence time is unknown.) Waters that meet these criteria--surface area greater than one hectare and hydraulic residence time greater than 14 d--will then be candidates for monitoring using the lake and reservoir BURP.

Water Body Selection

Idaho has more than 1,300 named lakes and reservoirs (Milligan et al. 1983). About 40 are on Idaho's 1996 § 303(d) list (Idaho Department of Health and Welfare 1997b). The following selection criteria are recommended in order to address current agency goals:

- water quality-limited lakes and reservoir [per Idaho's 1996 § 303(d) list];
- lakes and reservoir with reference conditions;
- lakes and reservoirs sampled last year;
- lakes and reservoirs located in hydrologic units scheduled for priority subbasin assessments; and
- lakes and reservoir with little or no monitoring information.

Inclusion of previously sampled waters aids in the evaluation of temporal variability. Ten percent of the lakes and reservoirs will be re-sampled annually.

Existing Data Review

Idaho's lakes and reservoirs have been the focus of much monitoring since Kemmerer and others visited the state early this century (Kemmerer et al. 1923). Milligan et al. (1983) have provided a bibliography of studies conducted before the mid-1980s. Since then, federal and state agencies, universities, industries and businesses, and public interest groups have committed funds and effort to investigating the resources of numerous waters. Most of these efforts have focused on traditional measures of trophic state, that is, the physical and chemical properties of water (Milligan et al. 1983; Falter and Hallock 1987; Kann and Falter 1987; Bellatty 1989a; 1989b; 1990; 1991; Breithaupt 1990; Entranco Engineers, Inc. 1990, 1992; Rothrock 1995; Idaho Department of Health and Welfare 1996b; Montgomery Watson 1996). More recently, researchers have begun to incorporate biological monitoring of periphyton, aquatic macrophytes, macroinvertebrates, and fish (Hoelscher et al. 1993; Mossier 1993; Cobb et al. 1995; Lockhart 1995; Idaho Department of Health and Welfare 1997b).

A comprehensive review of data is important. It serves two purposes: eliminates collection of similar data that has been recently measured and provides a benchmark from which to evaluate temporal trends. This cost-effective step should be performed for each water body. As part of the "preplanning" process, the regional office contact should check for available data at resources such as:

- Idaho Department of Fish and Game;
- Idaho Division of Health (Health Districts);
- Idaho Department of Water Resources;
- Idaho Division of Environmental Quality (internal sources);
- Bureau of Land Management;
- Bureau of Reclamation;
- Natural Resource Conservation Service;
- Tribal Nations;
- Universities;
- U.S. Fish and Wildlife Service;
- U.S. Forest Service;
- U.S. Geological Survey;
- EDMS (IDWR);
- STORET (EPA);
- Internet searches (if access available);
- GIS coverages from DEQ and other agencies;
- Hydropower companies; and
- Other appropriate resources.

Site Selection

Spatial

Lakes and reservoirs may exhibit distinct areas. Most lakes have a single basin and thus will consist of a single homogenous unit. Larger lakes may have basins and reservoirs may have zones that are morphologically or hydrologically different. Each basin may be considered a separate unit. Different reservoir zones represent flowing, river-like conditions; transitional conditions; and lacustrine, lake-like conditions near a dam. Additional basins and zones should be sampled if one site is insufficient to adequately characterize the physical, chemical, and biological characteristics of the water body. No more than three (3) units per water body, each consisting of pelagic and littoral sites, should be monitored.

Sites are thought of as samples of the larger homogenous unit. Pelagic sites will typically be located at the maximum depth. Representative sites may be more appropriate for reservoir riverine and transitional zones. Littoral sites will include one or more of four macrohabitat shorezones: a swimming area or boat launch, a major inlet, a representative least-affected shoreline, and a representative affected shoreline..

Temporal

Field sampling is scheduled in the period from mid-June through late-August in order to obtain representative measures of lake and reservoir conditions during critical high temperature, maximum production, and high recreational use. The goal is to monitor each water body as close as possible to its annual peak biotic activity. A schedule was established to sample high-elevation and -latitude lakes and reservoirs in August and others with broader activity peaks sometime from mid-June through July.

Method

Measures will be taken consistently statewide to obtain reliable and comparable data. Table 1 lists the measures, method references, and levels of intensity. A (Q) after a measure indicates a quantitative measure while a (S) signifies a subjective (or qualitative) measure.

Table 1. Lake and reservoir Beneficial Use Reconnaissance Project measures, method references, and levels of intensity in 1998.

Measures	Method Reference	Level of Intensity
Bathymetry or Depth (Q)	Hamilton and Bergersen 1984	Measure maximum depth at regular intervals along evenly-spaced transects.
Water Clarity (Q)	Hamilton and Bergersen 1984	Measure Secchi-disk depth at pelagic sites.
Conductivity (Q)	Woods 1991	Measure depth profile at pelagic sites.
Dissolved Oxygen (Q)	Woods 1991	Measure depth profile at pelagic sites.
Hydrogen Ion Concentration (pH) (Q)	Woods 1991	Measure depth profile at pelagic sites.
Temperature (Q)	Woods 1991	Measure depth profile at pelagic sites.
Phytoplankton/ Chlorophyll *a* (Q)	Bellatty 1990	Collect water samples at pelagic sites. Composite water samples from five equally-spaced depth intervals, one immediately below the surface, in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or throughout the water column in unstratified waters.
Nutrients (Q,)	Bellatty 1990	Collect water samples at pelagic sites. Composite water samples from five equally-spaced depth intervals, one immediately below the surface, in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or throughout the water column in unstratified waters. Composite two water samples from one meter off of the bottom.
Zooplankton (Q)	Smith (1998)	Collect a vertical tow at pelagic sites. Tows are taken in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or from two meters off of the bottom in unstratified waters.

Measures	Method Reference	Level of Intensity
Photo Documentation and Diagrammatic Mapping (S)	U.S. Environmental Protection Agency 1997	Take photographs of each macrohabitat shorezone, in the littoral zone at each macrohabitat shorezone, and aquatic macrophytes per lake basin or reservoir zone. Map bathymetry transects, pelagic sites and macrohabitat shorezones, and areal coverage of each macrohabitat shorezone.
Shoreline Physical Habitat Characterization (S)	Kaufman and Whittier 1997	Record characteristics of each macrohabitat shorezone per lake basin or reservoir zone.
Littoral Bottom Substrate (S)	Kaufman and Whittier 1997	Record the dominant substrate size of each macrohabitat shorezone per lake basin or reservoir zone.
Periphyton (S)	Kaufman and Whittier 1997	Describe community growth and form of each macrohabitat shorezone per lake basin or reservoir zone.
Aquatic Macrophytes (Q and S)	Mossier 1993; Kaufman and Whittier 1997	Collect aquatic macrophytes along a horizontal "rake." Describe community growth and form and percent coverage of each macrohabitat shorezone per lake basin or reservoir zone.
Macroinvertebrates (Q)	Kinney et al. 1997	Collect grab samples from the soft substrata in the sublittoral zone or 2.5 x Secchi-disk depth at a representative site per lake basin or reservoir zone.
Fish (Q or S)	Not Applicable	Use existing data. Coordinate collection with the appropriate agency.
Fecal Coliform (Q)	Sylvester et al. 1990	Collect sample(s) at either a swimming area or boat launch. Coordinate with the DEQ Regional Office or other appropriate agency.

Description of Method Modifications

Bathymetry or Depth

Locate multiple transects representing a grid pattern to generate a depth-contour map of the water body. Map the grid with directional arrows on a diagram of the water body. Record the latitude and longitude using a Global Positioning System (GPS) and compass heading of your position at the beginning of each transect. Measure maximum depth using a fathometer at regular intervals along each transect. Regular intervals are determined by set intervals on a stop watch. Record your position using a GPS at the end of each transect.

Conductivity, Dissolved Oxygen, Hydrogen Ion Concentration (pH), Temperature

Measure conductivity, dissolved oxygen, pH, and temperature using a Hydrolab® or other similar multi-measure probe. Record at one meter depth intervals through the thermocline or to 20 m depth. Record at five meter depth intervals thereafter. Make an additional measurement at one meter off of the bottom in waters greater than 20 m deep.

Phytoplankton/Chlorophyll *a*

In stratified waters, composite five 2.2 L Van Dorn (or other similar horizontal bottle) samples taken at equally-spaced depth intervals in the euphotic zone (2.5 x Secchi-disk depth), one immediately below the surface. In unstratified waters, composite five 2.2 L Van Dorn bottle samples taken at equally-spaced depth intervals throughout the water column, one immediately below the surface. Mix samples thoroughly in a 14 L polyeurethane container. Filter a one liter sub-sample using a 0.7 μm glass fiber filter and a hand-operated vacuum filter apparatus at 20-30 psi under a boat canopy. Add one milliliter of magnesium carbonate with 10 ml filtrate left. Place filter in petri dish, wrap in aluminum foil, and chill to four degrees Celsius.

Draw a 250 ml sub-sample into an amber polyeurethane bottle. Fix with about two to three ml Lugol's solution or until "tea-colored." Chill to four degrees Celsius.

Nutrients

In stratified waters, composite five 2.2 L Van Dorn (or other similar horizontal bottle) samples taken at equally-spaced depth intervals in the euphotic zone (2.5 x Secchi-disk depth), one immediately below the surface. In unstratified waters, composite five 2.2 L Van Dorn bottle samples taken at equally-spaced depth intervals throughout the water column, one immediately below the surface. Mix the samples thoroughly in a 14 L polyeurethane container. Rinse a one liter cubitainer and lid twice with sample water. Draw a one liter sub-sample preserved with two milliliters of concentrated sulfuric acid.

Repeat the process with two 2.2 L Van Dorn bottle samples taken one meter off of the bottom.

Zooplankton

Collect a vertical tow through the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from two meters off of the bottom in unstratified waters using a 80 μm mesh Wisconsin-style plankton net. Tow the net using a "hand-over-hand" technique at about one meter per second rate. Wash contents down the net. Detach the collection bucket and partially immerse in chilled 95% ethanol. Care should be taken not to spill ethanol over the top of the collection bucket. Wash the contents into a container, label inside and outside with a label marked in either an alcohol-proof pen or pencil, and preserve with 70% ethanol.

Photo Documentation and Diagrammatic Mapping

Take a photograph of each macrohabitat shorezone. Photograph the littoral zone assessment at one, two, and three meters distance from shore at three evenly-spaced transects perpendicular to the shore in a 150 m horizontal macrohabitat shorezone using an underwater viewbox. Photograph a representative sub-sample of the aquatic macrophyte "rake" in a white dissecting pan. Diagrammatically map the bathymetric transects with directional arrows, pelagic sites, macroinvertebrate sampling sites, and macrohabitat shorezones and areal coverage.

Shoreline Physical Habitat Characterization

Record the water-level fluctuation, shoreline vegetation width, percent shoreline vegetative cover, shoreline substrate, and human influences for each macrohabitat shorezone per lake basin or reservoir zone. Noting dominant shoreline vegetation (*e.g.* trees, willows, grass) or alternate shoreline stabilization (*e.g.* rip-rap, car bodies) is encouraged.

Littoral Bottom Substrate

Record the dominant littoral bottom substrate at one, two, and three meters distance from shore at three evenly-spaced transects perpendicular to the shore in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations.

Periphyton

Describe the periphyton community's growth (none visible, sparse, moderate, or thick) and form (filamentous, pin cushiony, or gelatinous) at one, two, and three meters distance from shore at three evenly-spaced transects in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations.

Aquatic Macrophytes

Describe the aquatic macrophyte community's growth (none visible, sparse, moderate, or thick) and form (short stature, stems visible and not reaching waters surface, stems overlapping waters surface, or floating) at one, two, and three meters distance from shore at three evenly-spaced transects in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations. Record the percent areal coverage.

Drag a weighted rake five meters along a two meter depth contour at either a swimming area or boat launch macrohabitat shorezone per lake basin or reservoir zone. Dunk-wash the sample in a mesh bag and drain, wet weigh the sample, estimate the possible number of species, photograph a representative sample in a white dissecting pan, and chill to four degrees Celsius in Ziploc© bags. Freeze in the laboratory for later identification.

Macroinvertebrates

Collect three replicate Petite ponar dredges at a representative macrohabitat shorezone per lake basin or reservoir zone. Samples should be collected from soft substrata in the sublittoral zone or 2.5 x Secchi-disk depth. Sieve the samples through a standard 500 μm screen. Place the sample into a container, label inside and outside with a label marked in either an alcohol-proof pen or pencil, and preserve with 70% ethanol. Contents should be divided into two containers if the container is more than one-half full of sample material.

Recommended Procedural Sequence for Water Body Evaluation

- Conduct pre-monitoring steps to gather all existing physical, chemical, and biological data. Coordinate monitoring efforts (*e.g.* fish and bacteria) with federal, state, and local governmental agencies or entities.

- Generate a bathymetric map if none exists. (This is very time consuming, so making exhaustive efforts to find existing maps is highly recommended.) Survey for appropriate pelagic and macrohabitat shorezone sites and map areal extent of macrohabitat shorezones while recording depths or if a bathymetric map already exists.

- Select the maximum depth or representative reservoir riverine or transitional pelagic site. Anchor the boat.

- Measure Secchi-disk depth.

- Record water-quality measure depth profiles with the Hydrolab®.

- Collect five water samples from throughout the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from throughout the water column in unstratified waters. Filter a one liter sub-sample for chlorophyll *a*. Draw a 250 ml sub-sample for phytoplankton speciation. Rinse a one liter cubitainer twice and draw and preserve a sub-sample for nutrients. Label for the appropriate depth strata. Chill all sub-samples to four degrees Celsius.

- Collect two water samples from one meter off of the bottom. Rinse a one liter cubitainer twice and draw and preserve a sub-sample for nutrients. Label the appropriate depth strata. Chill the sub-sample to four degrees Celsius.

- Collect a vertical tow throughout the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from two meters off of the bottom in unstratified waters with a Wisconsin-style zooplankton net. Immerse collection bucket in 95% ethanol. Label and preserve (70% ethanol) the sample.

- Select and photograph appropriate macrohabitat shorezones. Complete shoreline physical habitat characterization. Describe the periphyton and aquatic macrophyte community and littoral bottom substrate. Record the percent aquatic macrophyte coverage. Collect an aquatic macrophyte "rake", dunk-wash and drain the sample, wet-weigh, and photograph a representative sub-sample at either a swimming area or boat launch macrohabitat shorezone. Chill the sample in Ziploc© bags and freeze in the laboratory.

- Select and map a representative sublittoral location for macroinvertebrate sampling. Collect three replicates, seive, label, and preserve with 70% ethanol.

- Repeat the preceding steps at all lake basins or reservoir zones.

- Complete any additional coordinated monitoring (*e.g.* fish or bacteria).

Quality Assurance and Quality Control

Collection of reliable and accurate monitoring and measurement data is the goal of the quality assurance and quality control tasks in the BURP. The five tasks aimed at enhancing reliability, accuracy, and consistency in lake and reservoir monitoring are: 1.) crew training; 2.) crew supervision; 3.) field reviews; 4.) equipment maintenance and calibration; and 5.) sample duplicates and blanks.

Crew Training

The DEQ Watershed Monitoring and Analysis Bureau staff provides crew training. The training covers all aspects of the Lake and Reservoir BURP protocols. Training provides hands-on experience in each measure for each BURP crew member. Training requires a minimum of two days: one day in a classroom and one day in the field. Lake and Reservoir BURP protocols may require additional skills such as boat and trailer handling.

All individuals involved in the field collection of the BURP data will be trained and certified in cardio-pulmonary resuscitation. This requirement will increase field safety. The individuals may be trained by the DEQ "in-house" or certification can be a hiring requirement.

Crew Supervision

The Lake and Reservoir BURP crew is provided supervision throughout the monitoring season. The DEQ is involved during the training and occasionally (biweekly as time allows) accompanies the crew in the field. Additionally, the DEQ provides weekly meetings before leaving for the field.

Field Reviews

A field review consists of the DEQ Watershed Monitoring and Analysis Bureau staff observing the Lake and Reservoir BURP crew performing measures and collecting samples from a water body. A review is scheduled to occur within about two weeks of crew training. The crew will have at least one review.

Additional training will be required if the reviewer observes deviations in performing monitoring protocols. The level of additional training will be dictated by the significance of the deviation. It will be determined if the deviation is likely to result in unacceptable data. Appropriate steps will then be taken.

Equipment Maintenance and Calibration

Field

All sampling equipment (*e.g.* bottles, nets) and other items that has come in contact with a sample and has the potential to contaminant other measures must be carefully examined and cleaned of any material after sampling is completed at any site. All equipment should be examined again prior to use at the next site and recleaned if needed.

Laboratory

The Hydrolab® or other similar multi-measure probe must be calibrated before leaving for the field following recommended procedures (Hydrolab Corporation 1995). Calibration standards and procedures will be recorded in a log.

Some measures are to be completed by parties other than the DEQ. Maintenance and calibration will be regularly performed as recommended in operations manuals and as part of contractual requirements.

Sample Duplicates and Blanks

Duplicates and blanks will be collected on ten percent of the water bodies. These are to test the laboratory's precision and potential field contamination. Duplicates are as the name implies. These will be collected for chlorophyll *a*, phytoplankton, nutrients, zooplankton, macroinvertebrates, and fecal coliform. Blanks will be collected for chlorophyll *a*, nutrients and fecal coliform. The chlorophyll *a* blank is collected by filtering one liter of de-ionized water in the field. The nutrient blank is one liter of de-ionized water collected and fixed in the field.

The regional office contact will perform the fecal coliform duplicates and blanks in concert with their sample collection. This is performed similarly to the wadable stream protocols. A blank sample container accompanies the empty sample container into the field. The blank is opened for a few seconds and is stored and transported similarly to the other samples.

Data Handling and Storage

Proper labeling and field documentation are conducted to demonstrate compliance with sampling protocol and to reduce misidentification of samples. A chain of custody is given to the receiving laboratory to assure proper sample transfer.

The DEQ Watershed Monitoring and Analysis Bureau staff will annually review field forms for completeness, accuracy, and consistency. Sample processing outside of the DEQ will be addressed in appropriate "request for proposals" and subsequent contracts.

Voucher specimens of all organisms collected are stored in glass vials of 70% ETOH (Clark and Gregg 1986) with proper locality, date, collector, and determination labels. These specimens are then available for any later verification that might be needed and for future research opportunities. The specimens are deposited in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell.

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Glossary

aquatic macrophyte - The larger, non-microscopic aquatic plants found in the littoral zone of lakes and streams.

beneficial use - Any of the various uses that may be made of water, including, but not limited to, water supply (agricultural, domestic, or industrial), recreation in or on the water, aquatic life, wildlife habitat, and aesthetics.

chlorophyll *a* - The dominant green, photosynthetic pigment in plants. A measure of aquatic plant production.

coliform - A group of bacteria found in the colons of animals and humans, but also in natural soil and water where organic content is high. The presence of coliform bacteria in water is an indicator of possible pollution by fecal material.

criteria - Either a narrative or numerical statement of water quality on which to base judgement of suitability for beneficial use.

designated use - A beneficial use listed for a water body or water bodies in a state's water quality regulations.

euphotic zone - The depth to which one percent of incident light penetrates. The lighted zone of a water body.

eutrophic - Literally "nutrient rich"; generally refers to a fertile, productive water body. Contrasts with oligotrophic.

eutrophication - The process of nutrient enrichment in aquatic systems, such that the productivity of the system is no longer limited by the availability of nutrients. This is a natural process but may be accelerated by human activities.

existing use - A beneficial use actually attained by a water body on or after November 28, 1975.

integrity - The extent to which all parts or elements of a system (e.g. aquatic ecosystem) are present and functioning.

lentic - Pertaining to standing waters (*e.g.* ponds, lakes, reservoirs).

littoral zone - The region along the lake or reservoir shore extending lakeward to the greatest depth occupied by rooted aquatic plants.

oligotrophic - Literally "nutrient poor"; generally refers to an infertile, unproductive water body. Contrasts with eutrophic.

pelagic - Referring to the open area of a lake or reservoir; from the littoral zone to the center of the water body.

phytoplankton - Aquatic plants, usually microscopic; sometimes consisting of a single cell.

pollution - Any alteration in the character or quality of the environment due to human activity that makes it unfit or less suited for beneficial uses.

reconnaissance - An exploratory or preliminary survey of an area.

reference conditions - Conditions that fully support beneficial uses; with little impact from human activity and representing the highest level of support attainable.

stratification - The forming or arrangement of layers. This is usually caused by differences in temperature and density between layers.

sublittoral - Referring to the deeper part of the littoral zone of a water body.

thermocline - Represented by the reduction in water temperature of one degree Celsius or greater.

trophic status - Referring to the nourishment status of a water body; *e.g.* eutrophic, oligotrophic.

water body - A specific body of water or geographically delimited portion thereof.

water quality -A term for the combined chemical, physical, and biological characteristics of water that affect its suitability for beneficial use.

zooplankton - Small invertebrate animals suspended in and passively drifting through the water column and insect larvae.

Appendix I. Lakes and Reservoirs Scheduled for Sampling in 1998

Water Body Name	Hydrologic Unit Code	Pacific Northwest River System
Black Canyon Reservoir	17050122	690
Lake Lowell	17050114	738
Blue Creek Reservoir	17050104	627
C.J. Strike Reservoir	17050101	414
Lake Walcott		
Anderson Ranch Reservoir		
Little Wood Reservoir	17040221	515
Mormon Reservoir	17040220	539
Pioneer Reservoir	17040212	380
Brown's Pond	17050123	897.01
Deadwood Reservoir		
Sage Hen Reservoir		
Williams Lake		
Bull Trout Lake		
(Alexander) Soda Springs Reservoir	16010201	252
Oneida Narrows Reservoir	16010201	234
Blackfoot Reservoir		
Palisades Reservoir		
Henry's Lake	17040202	106

Water Body Name	Hydrologic Unit Code	Pacific Northwest River System
Hauser Lake	17010305	1562
Twin Lakes	17010214	1561.1
Spirit Lake	17010214	1438
Brush Lake		
Spring Valley Reservoir		
Waha Lake		

Appendix II. Lake and Reservoir Field Equipment Check List Per Water Body

Equipment Description	Yes	No
General Equipment		
Boat		
Fire extinguisher		
Life vests (3)		
Gas/oil/grease		
Boat paddle		
Anchor		
Bucket		
Aluminum form holder		
Field forms (2)		
Bathymetry/Depth Equipment		
Global Positioning System		
Compass		
Fathometer		
Stop watch		
Water Clarity Equipment		
Secchi disk		
Conductivity, Dissolved Oxygen, pH, Temperature Equipment		
Hydrolab®		
Laptop computer		

Equipment Description	Yes	No
Chlorophyll *a*/Phytoplankton Equipment		
2.2-L Van Dorn bottle		
14-L churnsplitter		
Hand-operated vacuum pump filter apparatus		
De-ionized water		
0.7 μm glass fiber filters (4)		
Filter forceps		
Magnesium carbonate		
Petri dishes (3)		
Aluminum foil		
250-ml brown polyethylene bottles (3)		
Lugol's iodine solution		
Indelible marker		
Cooler		
Ice		
Nutrients		
2.2-L Van Dorn bottle		
14-L churnsplitter		
1-L cubitainers (8)		
De-ionized water		
2-ml ampules concentrated sulfuric acid (7)		
Indelible marker		
Cooler		
Ice		

Equipment Description	Yes	No
Zooplankton Equipment		
Wisconsin net		
Squirt bottle (70% ethanol)		
Immersion bath (95% ethanol)		
Sample containers (3)		
Preservative (70% ethanol)		
Field labels		
Indelible, alcohol-proof marker		
Photo Documentation and Diagrammatic Mapping Equipment		
Dry-erase board/markers		
Camera		
Film (144 exposures)		
Field forms (2)		
Shoreline Physical Habitat Characterization Equipment		
Tape measure		
Littoral Bottom Substrate Equipment		
Tape measure		
Viewbox		
Periphyton Equipment		
Tape measure		
Viewbox		
Aquatic Macrophyte Equipment		
Tape measure		
Viewbox		

Equipment Description	Yes	No
Rake		
Mesh wash bag		
Spring Scale		
White pan		
Ziploc© bags (6)		
Indelible marker		
Cooler		
Ice		
Macroinvertebrate Equipment		
Petite Ponar dredge		
500 μm seive bucket		
Sample containers (6)		
Squirt bottle (70% ethanol)		
Preservative (70% ethanol)		
Forceps		
Field labels		
Indelible, alcohol-proof marker		

Appendix III. Lake and Reservoir Field Forms

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Water Body Identification

Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ____

HUC: ______________ PNRS: ______________ WB ID No.: ______________

County: ______________ Ecoregion: ______________ Map Elevation (ft or m): ________

Location Relative to Population Center: ______________________________

Watershed Size (sq mi or sq km): ______________ Water Body Size (sq mi or sq km): ______________

Water Body Orientation: ______________ Fetch (mi or km): ______________ Relief (circle one): low moderate high

Inflow (cfs or cms): ______________ Outflow (cfs or cms): ______________

Weather Conditions (light intensity, relative wind speed and direction): ______________________________

Surface Conditions (circle one): Flat Ripples Choppy Whitecaps Crew: ______________

Observed Activities (circle all that apply): Swimming Boating Fishing Dredging Hydropower Other: ________

Additional Information

(include number and type of recreationalists, species of fishes and wildlife observed, number and type of camping units, sanitation facilities, condition of boat launch, and maximum water-level fluctuation):

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Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ /

Detailed Drawing of Water Body

Shoreline and in-lake codes: FST=forest; LGG=logging; MNG=mining; GRZ=grazing; PTR=pasture; FLT=feedlot; CRP=cropland; IND=industry; HPR=hydropower; LHD=lowhead dam; DVN=diversion; RDS=roads; BDG=bridge; URB=urban; RSO=residence; LFL=landfill/dump; DWS=domestic water supply; SWR=stormwater outfall; WTR=wastewater outfall; BCH = beach; PRK = park; RST=resort; CMP=campground; PNC=picnic; LDS=landslide; SLP=slump/mass wasting; ERO=erosion; ALT=altered shoreline; SHL=shoal/rocks; RMP=boat ramp; DCK=dock; MNA=marina; WET=wetland; FLM=floating macrophytes; SBM=submerged macrophytes; EMM=emergent macrophytes; ______=

Name: ______________________ Site ID: 1998 Q ________ Date (YY/MM/DD): 98/ /

START	Transect __	Transect __	Transect __	Transect __	Transect __
Latitude (ddmmss):					
Longitude (ddmmss):					
Compass Heading:					
Time (military):					
STOP					
Time (military):					
Latitude (ddmmss):					
Longitude (ddmmss):					

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Name: ______________________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

START	Transect __	Transect __	Transect __	Transect __	Transect __
Latitude (ddmmss):					
Longitude (ddmmss):					
Compass Heading:					
Time (military):					
STOP					
Time (military):					
Latitude (ddmmss):					
Longitude (ddmmss):					

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Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Hydrolab Calibration

Date of Calibration (YY/MM/DD) 98/ / ______ % Sat. Calibration @ Barometric Pressure of: ______

pH Calibration w/ Standard of: ______ Conductivity Calibration w/Standard of: ______

Water-Quality Depth Profiles

Latitude (ddmmss): ______ Longitude (ddmmss): ______

Location Description: ______

Hydrolab Filename: ______ Time (military): ______

Maximum Depth (ft or m): ______ Secchi Depth (m): ______

Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)	Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)
Indicate top (T) and bottom (B) of thermocline					Indicate top (T) and bottom (B) of thermocline				

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Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Water Sample Collection

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________________

Chlorophyll a

Time Filtered (military): ______________ Volume Filtered (ml): ______________

Comments: ______________________________

Phytoplankton

Time Collected (military): ______________

Comments: ______________________________

Nutrients

	Total Phosphorus (1 L fixed)		Comments:
Time Collected (military):	Surface	Bottom	
Sample:			
Duplicate:			
Blank:			

Zooplankton

Time Collected (military): ______________

Comments: ______________________________

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
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Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Associated Location Description: ______________________

Shoreline Habitat Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Shoreline Vegetation Width (m):				
Percent Shoreline Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban				
Recreation				
Wilderness/Refuge				
Other ______				

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Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Associated Location Description: ______________________

Littoral zone

	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ____________________ Site ID: 1998 ____ Q ____ Date (YY/MM/DD): 98/ ___ / ___

Associated Location Description: ____________________

Photograph Information

Roll (name or number): ____________________

Circle All That Apply:

Photo #:	Swimming/Boating			Major Inlet			Least Affected		Affected
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	Swimming/Boating			Major Inlet			Least Affected		Affected
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

Circle All That Apply:

Photo #:	Swimming/Boating			Major Inlet			Least Affected		Affected
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	Swimming/Boating			Major Inlet			Least Affected		Affected
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

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Idaho Division of Environmental Quality

Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Hydrolab Calibration

Date of Calibration (YY/MM/DD) 98/ / ______

% Sat. Calibration @ Barometric Pressure of: ______

pH Calibration w/ Standard of: ______

Conductivity Calibration w/Standard of: ______

Water-Quality Depth Profiles

Latitude (ddmmss): ______

Longitude (ddmmss): ______

Location Description: ______

Hydrolab Filename: ______

Time (military): ______

Maximum Depth (ft or m): ______

Secchi Depth (m): ______

Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)	Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)
Indicate top (T) and bottom (B) of thermocline					Indicate top (T) and bottom (B) of thermocline				

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ________________ Site ID: 1998 ______ Q ______ Date (YY/MM/DD): 98/ ___ / ___

Water Sample Collection

Latitude (ddmmss): ________________ Longitude (ddmmss): ________________

Location Description: ________________

Chlorophyll a

Time Filtered (military): ________________ Volume Filtered (ml): ________________

Comments: ________________

Phytoplankton

Time Collected (military): ________________

Comments: ________________

Nutrients

Time Collected (military):	Total Phosphorus (1 L fixed)		Comments:
	Surface	Bottom	
Sample:			
Duplicate:			
Blank:			

Zooplankton

Time Collected (military): ________________

Comments: ________________

Name: ____________________ Site ID: 1998 Q ____________ Date (YY/MM/DD): 98/ / ____

Associated Location Description: ______________________________

Shoreline Habitat Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Shoreline Vegetation Width (m):				
Percent Shoreline Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban				
Recreation				
Wilderness/Refuge				
Other ____________				

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Idaho Division of Environmental Quality

Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Associated Location Description: ______________________

Littoral zone

	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

Name: ______________________ Site ID: 1998 Q Date (YY/MM/DD): 98/ /

Associated Location Description: ______________________

Photograph Information

Roll (name or number): ______________________

Circle All That Apply:

Photo #:	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

Circle All That Apply:

Photo #:	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #:	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ______________________ Site ID: 1998 Q __________ Date (YY/MM/DD): 98/ / ______

Hydrolab Calibration

Date of Calibration (YY/MM/DD) 98/ / ______

% Sat. Calibration @ Barometric Pressure of: ______

pH Calibration w/ Standard of: ______

Conductivity Calibration w/Standard of: ______

Water-Quality Depth Profiles

Latitude (ddmmss): ______

Longitude (ddmmss): ______

Location Description: ______

Hydrolab Filename: ______

Time (military): ______

Maximum Depth (ft or m): ______

Secchi Depth (m): ______

Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)
Indicate top (T) and bottom (B) of thermocline				

Depth (ft or m)	Temp. (C)	pH	Conductivity	DO (ppm)
Indicate top (T) and bottom (B) of thermocline				

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ______________________ Site ID: 1998 Q ________ Date (YY/MM/DD): 98/ / ________

Water Sample Collection

Latitude (ddmmss): ________ Longitude (ddmmss): ________

Location Description: ________

Chlorophyll a

Time Filtered (military): ________ Volume Filtered (ml): ________

Comments: ________

Phytoplankton

Time Collected (military): ________

Comments: ________

Nutrients

Time Collected (military):	Total Phosphorus (1 L fixed)		Comments:
	Surface	Bottom	
Sample:			
Duplicate:			
Blank:			

Zooplankton

Time Collected (military): ________

Comments: ________

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ____________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Associated Location Description: ____________________

Shoreline Habitat Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Shoreline Vegetation Width (m):				
Percent Shoreline Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban				
Recreation				
Wilderness/Refuge				
Other ____________				

Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ /

Associated Location Description: ______________________

Littoral zone

	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

1998 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Division of Environmental Quality

Name: ______________________ Site ID: 1998 Q ______ Date (YY/MM/DD): 98/ / ______

Associated Location Description: ______________________

Photograph Information

Roll (name or number): ______________________

Circle All That Apply:

Photo #:									
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

Circle All That Apply:

Photo #:									
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M